355 Harmonics Analyzer User's Guide

Warning! *The connection instructions in this user's guide are for use by qualified personnel only. Do not install this instrument unless you are qualified to do so. High voltages that cause burns and lethal shocks are present during power monitoring.*

600 VAC MAX

This symbol indicates maximum input voltage to instrument not to exceed 600 V_{rms}.

Protective ground (earth) terminal.

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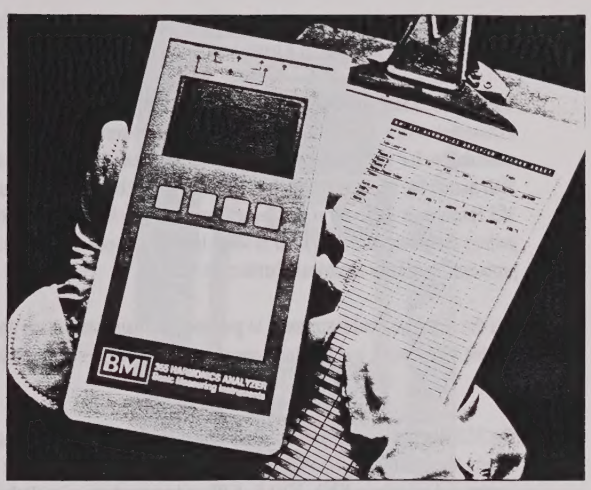
1 Product Overview



BMI's handheld 355 Harmonics Analyzer

Harmonics are a growing problem in today's electrical distribution systems. The widespread use of personal computers, programmable logic controllers, adjustable speed drives, and electronic controls, have elevated harmonics to critical levels in many facilities. Harmonics can cause overheated transformers, failed motors, disrupted electronic systems, and even fires. The key to solving harmonics problems is having the right knowledge.

In three-phase power systems, it is important to keep close tabs on harmonics. With the possibility of unbalanced loads and harmonics being generated from multiple sources, all three phases must be examined together.

Until now, the only way to measure three-phase harmonics was with a dedicated power monitor, designed for long term monitoring and data-logging of power flow and harmonics. These provide exceptionally accurate harmonics diagnostic capabilities along with many very advanced power flow and demand features, but are relatively expensive and heavy. In situations requiring rapid spot-checking of dozens or hundreds of points in a plant or facility, the power monitors may be cumbersome. Alternatively, a small single-phase harmonics meter could be used to measure three-phase harmonics, albeit one phase at a time. An instrument was needed to combine

the three-phase harmonics capabilities of the power monitors with the portable size and low cost of a hand-held harmonics meter.

The BMI 355 Harmonics Analyzer is a hand-held, battery operated, 3-phase instrument with a graphic LCD display. It provides simultaneous waveshapes for voltage and current, harmonic spectrum display through the 50th harmonic, and power flow calculations for all three phases. The BMI 355 Harmonics Analyzer is an inexpensive spot-checking device, which gathers the information required to solve tough three-phase harmonics problems in today's electrical distribution systems.

It is the first handheld instrument to provide simultaneous voltage and current waveshapes and harmonic spectrum to the 50th for three phase power.

The 355 Harmonics Analyzer measures harmonic distortion for voltage and current through the 50th harmonic. It also measures true rms voltage and current and calculates KVA, KVAR, KW, and power factor for all three phases. This information, along with the voltage and current waveform, is displayed on an LCD display built into the analyzer.

The 355 Harmonics Analyzer operates on 50 Hz or 60 Hz electrical systems. Four voltage connectors are included with the 355 Harmonics Analyzer, which clamp onto each phase and the neutral. Clamp-on current probes (ordered separately) are also available, in maximum capacities ranging from 60 amps to 3000 amps.

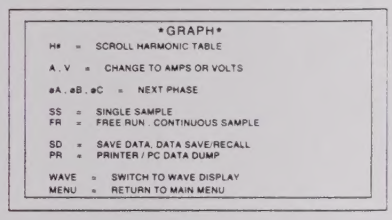
As with all BMI products, the user interface is simple and intuitive. Menu selections are made using cursor positioning ("Down/Left", "Up/Right") and "Enter" keys. The on-line "definitions" help feature allows help to be accessed with just a few keystrokes from any other screen in the 355 Harmonics Analyzer.

Up to eight complete sets of collected three-phase data may be saved in the 355 Harmonics Analyzer for later viewing. Instrument data may be printed from the 355 Harmonics Analyzer from either saved data or present data with the optional thermal printer (ordered separately), or may be recorded manually onto customized record sheets included with the instrument. Data may also be downloaded to an IBM PC compatible computer for importation into any standard spreadsheet program.

Using the Definitions Feature

The 355 Harmonics Analyzer's built-in "definitions" feature presents a built-in text file containing information on commonly used acronyms and how to use the 355 Harmonics Analyzer. To use the definitions feature, simply select "definitions" from the main menu. This loads the definitions text file onto the screen. To scroll from page to page, use the left and right cursor control keys (arrow keys). Information contained in the definitions file is listed under the following headings:

- SWITCHES
- MAIN MENU
- GRAPH
- WAVE
- POWER
- WAVE/POWER
- SET-UP
- SAVE DATA
- PRINTER/PC
- REMOTE COMMUNICATIONS
- LOBAT


GRAPH
H# = SCROLL HARMONIC TABLE
A , V = CHANGE TO AMPS OR VOLTS
#A , #B , #C = NEXT PHASE
SS = SINGLE SAMPLE
FR = FREE RUN , CONTINUOUS SAMPLE
SD = SAVE DATA, DATA SAVE/RECALL
PR = PRINTER / PC DATA DUMP
WAVE = SWITCH TO WAVE DISPLAY
MENU = RETURN TO MAIN MENU

Sample Definitions file: Graph

When the desired information is displayed on the screen, use the enter key to exit and return to the main menu. The GRAPH, WAVE, or POWER screens may then be loaded to return to the display of harmonic or power flow data. To refer back to the definitions text, exit and reload the definitions text, to the page of definitions. The page number will be retained until the 355 Harmonics Analyzer is powered off.

How to Contact BMI

Regardless of your location, BMI sales and product support are within easy reach through an established network of representatives and distributors worldwide. For technical support, specific product information, or the name of a BMI representative in your area, contact BMI by telephone at **(800) 888-2648** in the U.S. or (408) 970-3700 outside the U.S. You can also fax BMI at (408) 970-3720.

1 Product Overview

355 Harmonics Analyzer

The 355 Harmonics Analyzer and Accessories

A. *355 Harmonics Analyzer*

B. *Foam-lined carrying case (optional):* The carrying case is molded plastic with locking latches and a custom-cut foam lining designed to protect the 355 Harmonics Analyzer and accessories. The attaché-type case can be easily carried on aircraft or checked as luggage. The case is included as a part of the 355 Starter Kit.

C. *Four Standard Voltage Connectors:* Each 355 Harmonics Analyzer includes four voltage clip connectors, suitable for measurements up to 600 V_{rms}. For increased safety, we recommend the optional 355 Starter Kit (BMI part number S-301) with FuseClip™ Voltage connectors.

D. *Four FuseClip™ Voltage Connectors (optional):* The spring-loaded clamping jaws attach quickly and securely to the each phase and the neutral of the voltage source. The replaceable in-line fuses protect against fire, injury, and equipment damage. The FuseClips are included as a part of the 355 starter kit.

FuseClip Voltage Connector

E. *Clamp-On Current Transformers (optional):* Current inputs to the 355 Harmonics Analyzer are provided by three clamp-on current transformers with extended frequency ranges to 5 kHz and current ranges of 60 amps, 600 amps, or 3000 amps. The CT's are insulated for use on up to 600 volts rms.

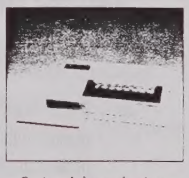
Optional current probes

Warning! *For safety and compatibility reasons, do not use other current probes.*

F. *Record Sheets:* Customized record sheets are provided with the 355 Harmonics Analyzer for recording information when the optional thermal printer is not used.

G. *Extra Batteries (optional):* An extra set of four AA alkaline batteries is included with the 355 starter kit.

H. *Thermal Printer (optional):* The thermal printer provides a permanent record of data collected by the meter.



Optional thermal printer

I. *Printer Data Cord (optional):* The printer data cord is used to connect the printer to the meter. It is included with the thermal printer.

J. *Battery Charger (optional):* The battery charger is for the rechargeable NiCad batteries in the thermal printer. It is included with the thermal printer.

K. *Spare Printer Paper Roll (optional):* An extra roll of paper is provided with the printer option.

L. *PC Interface Cable (optional):* The PC interface cable allows transfer of instrument data directly into an IBM PC or compatible computer. The cable is six feet in length.

Cell Number	Description
31	% Displacement Power Factor Three Phase Total
32	IEEE or IEC Harmonics Format
33	Phase – A
34	Current Label – A
35	% THD
36	Harmonic % #1
37	Harmonic Magnitude #1
	...
134	Harmonic % #50
135	Harmonic Magnitude #50
136	Phase – A
137	Voltage Label – V
138	% THD
139	Harmonic % #1
140	Harmonic Magnitude #1
	...
237	Harmonic % #50
238	Harmonic Magnitude #50
239	Phase – B
240	Current Label – A
241	% THD
242	Harmonic % #1
243	Harmonic Magnitude #1
	...
340	Harmonic % #50
341	Harmonic Magnitude #50
342	Phase – B
343	Voltage Label – V
344	% THD
345	Harmonic % #1
346	Harmonic Magnitude #1
	...
443	Harmonic % #50
444	Harmonic Magnitude #50
445	Phase – C
446	Current Label – A
447	% THD
448	Harmonic % #1
449	Harmonic Magnitude #1
	...
546	Harmonic % #50
547	Harmonic Magnitude #50
548	Phase – C
549	Voltage Label – V
550	% THD
551	Harmonic % #1
552	Harmonic Magnitude #1
	...
649	Harmonic % #50
650	Harmonic Magnitude #50
651-906	Current Waveform Data, Phase A

Cell Number	Description
907-1162	Voltage Waveform Data, Phase A
1163-1418	Current Waveform Data Phase B
1419-1674	Voltage Waveform Data, Phase B
1675-1930	Current Waveform Data Phase C
1931-2186	Voltage Waveform Data, Phase C

Three-phase Serial Data Transfer Procedure

1. Connect the optional BMI Serial Cable (BMI part number IF-155) between the serial port on the 355 Harmonics Analyzer and one of the Comm ports on the PC.

2. Use a PC-based (DOS or Windows) communications package (Terminal, PROCOMM, etc.) to capture the 355 Harmonics Analyzer data. Set up the communications parameters as follows:

   - *Baud rate:* 4800
   - *Data Bits:* 8
   - *Stop Bits:* 1
   - *Parity:* None
   - *Flow Control:* None
   - *Parity Check:* None
   - *Carrier Detect:* None
   - *Comm. Port:* Number of the PC Comm. port connected to

3. To transfer data, instruct the PC communications program to capture a text file. Give the text file a name which has an extension of ".CSV" for comma separated variable data. Select the 355 Harmonics Analyzer menu option labeled "PR", then select "Send Data". All of the voltage and current data shown on the instrument display will be sent to the file you have defined in your communication program. When the 355 Harmonics Analyzer is finished sending data, close the file within your communication program.

4. To view the data in spreadsheet, simply open the CSV file in the spreadsheet application as you would any other text file. It may then be formatted for graphs or reports. The data is on one continuous column, formatted as follows:

Cell Number	Description
1	Serial Output
2	Vrms Phase A
3	Vrms Phase B
4	Vrms Phase C
5	Arms Phase A
6	Arms Phase B
7	Arms Phase C
8	KW Phase A
9	KW Phase B
10	KW Phase C
11	KW Three Phase Total
12	KVA Phase A
13	KVA Phase B
14	KVA Phase C
15	KVA Three Phase Total
16	Total KVAR Phase A
17	Total KVAR Phase B
18	Total KVAR Phase C
19	Total KVAR Three Phase Total
20	Displacement KVAR Phase A
21	Displacement KVAR Phase B
22	Displacement KVAR Phase C
23	Displacement KVAR Three Phase Total
24	% Total Power Factor Phase A
25	% Total Power Factor Phase B
26	% Total Power Factor Phase C
27	% Total Power Factor Three Phase Total
28	% Displacement Power Factor Phase A
29	% Displacement Power Factor Phase B
30	% Displacement Power Factor Phase

Continued...

355 Harmonics Analyzer front panel

The 355 Harmonics Analyzer Close Up

Inputs

Input jacks are clearly marked for four voltage probes, BMI CTs, and an RS-232 jack for the printer or PC communications. Each type of jack is unique, and color coded where required to prevent misconnections.

Warning! *Only the provided connecting cords should be used. Use of other cords may endanger the user and will void the warranty.*

Display

A backlit liquid crystal graphic display provides the readout for all 355 Harmonics Analyzer functions. The display indicates values as well as the function being observed, and the mode. The display is illuminated by selecting backlighting in the Set-up menu.

Push-Button Keys
Push-button keys on the front panel are used to select 355 Harmonics Analyzer operations. The 355 Harmonics Analyzer uses a menu-driven selection format which is fast and intuitive. Key descriptions can be found in the following section entitled Keyboard Functions.

IEEE and IEC Formats
The 355 Harmonics Analyzer presents harmonic information in one of two formats. The IEEE format in which the harmonics are calculated as a percent of the fundamental value, or the IEC format where the harmonic data is calculated as a percent of the rms value. The format desired may be selected from the Set-up menu. The display in the GRAPH screen indicates which version (IEEE or IEC) is currently being used. Even though the format can be changed at any time, there will not be a change in the calculated information until the next sample of data is taken.

50 Hz or 60 Hz Operation
To switch the fundamental frequency, select the desired frequency (50 or 60 Hz) from the Set-up menu.

Operating Instructions
Abbreviated operating instructions are located on the front panel for easy reference while troubleshooting.

Definitions
On-line help is available in the "Definitions" menu selection. This feature defines commonly used monitoring terms and acronyms, and explains how to adjust and operate the 355 Harmonics Analyzer. The help can be accessed with just a few keystrokes from any other screen in the 355.

Battery Compartment
Four AA alkaline batteries are contained in the battery compartment on the back of the 355 Harmonic Analyzer. Detailed instructions on how to change the batteries can be found in the section entitled *Instructions for Specific Operations*.

Warning! *Rechargeable NiCad batteries must not be used in the 355 Harmonics Analyzer. Use of NiCads will cause operational problems and may damage the analyzer.*

Saving Data
The BMI 355 Harmonics Analyzer includes a "Save Data" feature, which provides saving and retrieving of up to eight separate sets of three-phase readings. The "SD" submenu may be called up from any of the three main data displays (GRAPH, WAVE, and POWER).

To save the readings which are currently shown on the instrument, load the "SD" (Save Data) submenu. Set the sample # to a number from 1 to 8, using a memory location which is either empty or no longer needed.

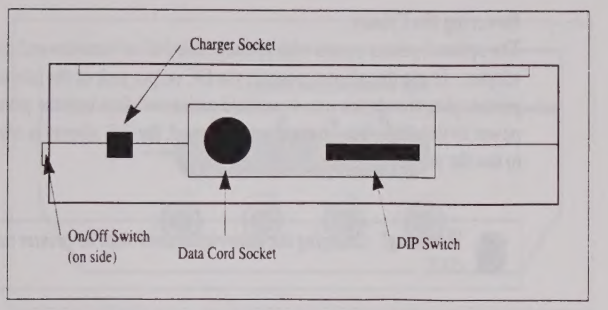
Warning! *Saving instrument readings will overwrite previous values stored in the same memory location number. The overwritten readings cannot be recovered.*

Move the cursor to the "Save Sample" menu option and press the enter key. The complete set of current and voltage readings are now saved in memory, and may be retrieved for later use.

Retrieving Data
To retrieve instrument readings which have been saved using the "Save Data" feature, first load the "SD" submenu. Set the sample # to a number from 1 to 8, corresponding to the desired sample. Move the cursor to the "Recall Sample" menu option and press the enter key. The complete set of current and voltage readings will be loaded into the instrument, and may be viewed the same way that any other "Single Shot" data is viewed.

The "Clear All Samples" menu option will erase all eight samples in the 355 Harmonics Analyzer's memory. Once this function has been selected, this data cannot be retrieved.

As a precaution, the "Auto-increment" function may be selected. Once a set of readings has been stored in a memory location (from 1 to 8), the sample number will automatically increment to the next number, making it less likely that a new set of readings will be accidentally saved over other valuable readings.



Optional thermal printer, back view—making connections

Whenever the "Printer Start/Stop" menu option is set to "start", the 355 Harmonics Analyzer will go into its print mode. The print mode freezes data in FREE RUN mode, or uses the existing single shot data. When printer "start" has been selected, the following will be printed:

POWER DATA:
- True rms voltage and current - Phase A, B, and C
- KW Power - Phase A, B, C, and Total Three-Phase
- KVA - Phase A, B, C, and Total Three-Phase
- True KVAR - Phase A, B, C, and Total Three-Phase
- Displacement KVAR - Phase A, B, C, and Total Three-Phase
- True Power Factor - Phase A, B, C, and Total Three-Phase
- Displacement Power Factor - Phase A, B, C, and Total Three-Phase

HARMONICS (if selected):
- Harmonic THD% - Phase A, B, and C
- 50 Harmonic Distortion Factors - Phase A, B, and C
- 50 Individual Harmonic Currents - Phase A, B, and C
- 50 Individual Harmonic Voltages - Phase A, B, and C

WAVES (if selected):
- Voltage Waveforms - Phase A, B, and C
- Current Waveforms - Phase A, B, and C

GRAPH (if selected):
- Harmonic Spectrum Bar Graph - Phase A, B, and C

When the 355 Harmonics Analyzer is set-up to be used as a single-phase instrument, only data for phase A will be printed.

Keyboard Functions

Key	*Function*
ON/OFF:	Turns the instrument on and off. To turn the power on, press this key instantaneously. After the main menu is displayed, the cursor left/right keys may be used to adjust the LCD contrast. When the contrast is adjusted, press "enter" to begin instrument operation. To turn off the power to the 355 Harmonics Analyzer, press and hold the "on/off" key until a horizontal line appears in the display (about two seconds) and let go of the key. This delay is designed to prevent the user from inadvertently turning the instrument off during use. After the power is turned off, the last mode and range settings are stored, along with up to eight complete sets of current and voltage readings which were saved using the "save data" feature.
CURSOR Down/Left:	Moves the on-screen cursor down in vertical menus, and left in horizontal menus. When you press and hold down this key, it will repeat.
CURSOR Up/Right:	Moves the on-screen cursor up in vertical menus, and right in horizontal menus. When you press and hold down this key, it will repeat.
ENTER:	Selects and executes highlighted functions from on-screen menus. When you press and hold down this key, it will not repeat.

Menu Descriptions

The BMI 355 Harmonics Analyzer uses a set of simple on-screen menus for instrument control and operation. The initial "main" menu is vertical, and contains five choices. These choices lead to other menus or, in the case of "Definitions", immediate help. To select a menu option, use the "arrow" keys to move the cursor until it points to the desired choice, then press "Enter".

Main Menu:

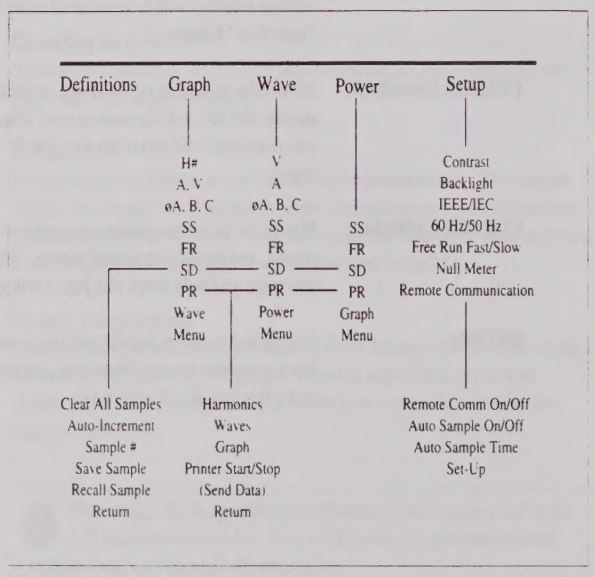
DEFINITIONS

GRAPH

WAVE

POWER

SETUP



355 Harmonics Analyzer Menu Flowchart

Powering the Printer

The optional printer comes with rechargeable NiCad batteries and an AC adapter. To use the adapter, connect the DC output jack of the adapter to the printer, plug the adapter into a standard outlet, and then turn the printer's power switch ON. If the batteries are charged, the AC adapter is not needed to use the printer.

Warning! *Charging the batteries is done with he printer turned OFF.*

Printer Setup

In order for your printer to operate, the DIP switches at the rear of the unit must be set properly.

Switch #6 and #8 must be in the DOWN (ON) position, and all other switches must be in the UP (OFF) position. If you experience any problems, please consult the printer's user's guide, or call BMI Technical Support at **(800) 888-2648**, or (408) 970-3700.

Printer Self Test

The printer self test can be performed by holding down the paper feed (PF) key on the printer and turning the printer power switch ON. Turning the power switch OFF ends the test.

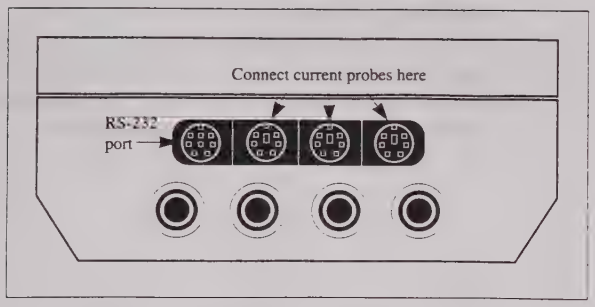
Connecting the Printer

Both the printer and the analyzer should be turned off when the printer is being connected. Connect the printer to the RS-232 port on the analyzer using the supplied eight-pin mini-DIN connector cord.

Warning! *Do not disconnect the printer from the analyzer while data is being transferred. This may cause the instrument to malfunction.*

Printing

To print data on the printer, ensure that the printer is connected to the 355 Harmonics Analyzer, and that both the analyzer and the printer are ON.



355 Harmonics Analyzer, top view—making current connections

Warning! *These CTs are not compatible with BMI SmartProbes™ or ID probes.*

Changing Batteries

The analyzer is powered by four (4) size AA alkaline cells. No other type of battery should be used.

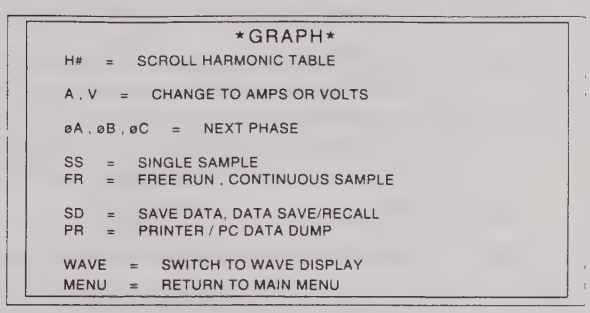
Warning! *NiCad batteries will not operate this analyzer.*

To replace the batteries, turn the analyzer off and place it face down on a padded surface. Remove the two battery compartment screws, and open the compartment. Remove the old batteries and replace them with new ones. Make sure the batteries are placed correctly in the compartment. Replace the cover and the screws.

Warning! *Stored readings in the 355 Harmonics Analyzer will be retained for about one minute while the batteries are changed. If the analyzer is without power for a longer period, these stored readings will be lost.*

Definitions Menu

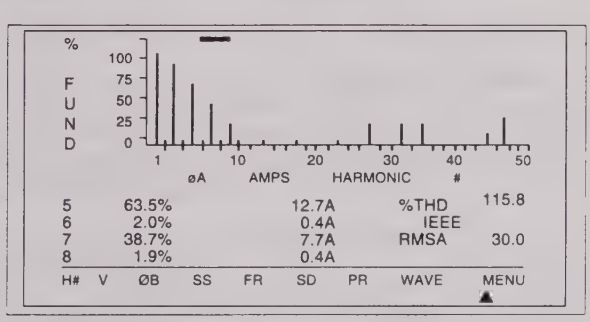
The definitions menu selection contains information on commonly used acronyms and how to use the 355 Harmonics Analyzer. To display the definition information, simply scroll through the text file using the cursor control keys. When done, use the enter key to return to the main menu.


GRAPH
H# = SCROLL HARMONIC TABLE
A , V = CHANGE TO AMPS OR VOLTS
øA , øB , øC = NEXT PHASE
SS = SINGLE SAMPLE
FR = FREE RUN , CONTINUOUS SAMPLE
SD = SAVE DATA, DATA SAVE/RECALL
PR = PRINTER / PC DATA DUMP
WAVE = SWITCH TO WAVE DISPLAY
MENU = RETURN TO MAIN MENU

Typical Definitions screen

Graph Menu

The graph menu option is your primary tool for harmonics troubleshooting. The graph display includes a bar graph of the harmonic spectrum from the first through the 50th harmonic. The display also shows individual harmonic percentages, currents, voltages, total harmonic distortion, true rms voltage, and true rms current. A description of the menu options follows:



Graph Menu

H#: Scrolls the text display to the next group of four harmonics for detailed analysis of individual harmonics percentages and rms current and voltage.

A, V: Switches between display of current and voltage harmonics.

ØA, B, C: Switches between phases A, B, and C (for three phase only).

SS: Enables "Single-Shot" data capture. This selection causes the 355 Harmonics Analyzer to calculate all harmonics and power flow values based on a sample of four cycles of power. The captured data is displayed until "SS" is chosen again, or until "FR" is selected. Data may be saved using the "SD" option.

FR: "Free Run" mode allows continuous readings of current and voltage as well as the updating of harmonics and power flow calculations. The sampling rate is either once per second or once every four seconds, depending upon the rate chosen in the "set-up" menu.

SD: The "Save Data" menu option calls up a submenu, allowing saving and retrieving of up to eight separate three-phase readings. The "SD" submenu has the following choices:

CLEAR ALL SAMPLES: Erases memory of saved instrument readings.

AUTO-INCREMENT: Increments the sample number when a sample is saved or recalled.

SAMPLE #: Sets sample number from one to eight.

SAVE SAMPLE: Saves all data for last sample taken into "Sample #" field.

RECALL SAMPLE: Recalls all data for sample displayed in "Sample #" field.

RETURN: Returns to data display.

Making Voltage Connections

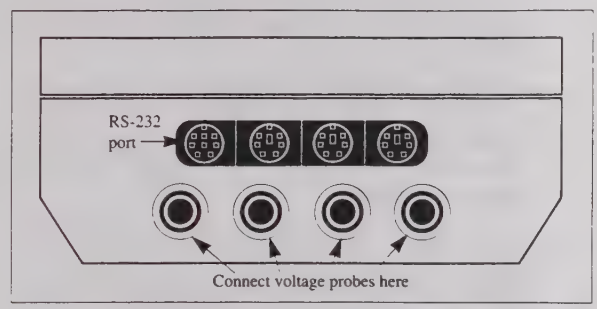
Each Voltage Connector is equipped on both ends with safety connectors. One end of the cord should be plugged into the clip and the other end into a safety connector on the analyzer as shown below. The cords should be plugged into the jack corresponding to the color code as follows:

Phase A: Red

Phase B: Yellow

Phase C: Blue

Neutral: White



355 Harmonics Analyzer, top view—making voltage connections

Connect the cords to the 355 Harmonics Analyzer before connecting the voltage clips to live voltage.

Warning! *Do not use connecting cords with ordinary banana plugs.*

Making Current Connections

The three current transformer connecting cords terminate in six-pin mini-DIN plugs. These plugs are inserted into the analyzer sockets marked CURRENT. Connect the CT cords to the 355 Harmonics Analyzer before placing the CTs around the line conductors.

PR: The "Printer" menu option calls up a submenu, allowing saving and retrieving of up to eight separate three-phase readings. The "SD" submenu has the following choices:

HARMONICS:	Enables printing of harmonic THD and all 50 harmonic values.
WAVES:	Enables printing of voltage and current waveforms.
GRAPH:	Enables printing of harmonic spectrum bar graph.
PRINTER START/STOP:	Starts and stops printing.
RETURN:	Returns to data display.

If the 355 Harmonics Analyzer detects a serial interface cable, the following menu items will be displayed in the printer menu:

SEND DATA:	Sends data to the PC.
RETURN:	Returns to data display.

WAVE: Loads "Wave" menu and display.

MENU: Returns to main menu.

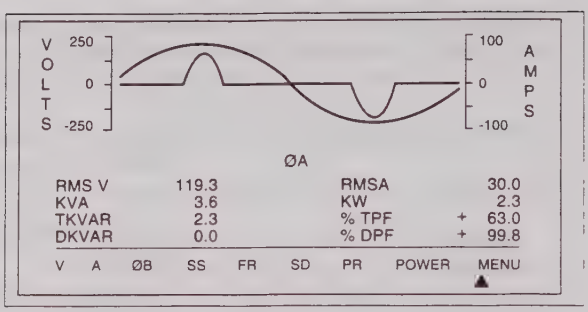
Wave Menu

The wave menu option allows simultaneous display of voltage and current waveforms. Power flow values are displayed at the bottom of the screen, including true rms voltage and current, true KVAR, displacement KVAR, KW, true power factor, and displacement power factor. The following menu options select specific operation:

V: Turns voltage waveform on and off.

A: Turns current waveform on and off.

øA, B, C: Switches between phase A, B, and C.



Wave Menu

SS: Enables "Single-Shot" data capture (described above).

FR: Puts the Analyzer into "Free Run" mode (described above).

SD: Loads "Save Data" submenu (described above).

PR: Loads "Printer" submenu (described above).

POWER: Loads "Power" menu and display.

MENU: Returns to main menu.

Power Menu

The power menu option summarizes the power flow values calculated for each phase, and totals the three-phase values for true KVAR, displacement KVAR, KW, KVA, true power factor, and displacement power factor. Individual per phase readings are shown for true rms voltage and current.

SS: Enables "Single-Shot" data capture (described above).

FR: Puts the Analyzer into "Free Run" mode (described above).

SD: Loads "Save Data" submenu (described above).

PR: Loads "Printer" submenu (described above).

GRAPH: Loads "Graph" menu and display.

MENU: Returns to main menu.

- Clamp the current probes around the conductors to be measured. Be sure to align the current probes with the correct phases. Observe the direction of current flow indicated on the probes.

- Clip the voltage probes to the terminals to be measured, using the color code as follows:

Phase A: Red

Phase B: Yellow

Phase C: Blue

Neutral: White

The maximum voltage is 600 V_{rms}.

7. While on the wave display, use the ØA/B/C selection to view each phase and verify voltage and current probe phasing.

8. Move the cursor to the "graph" selection, and press "enter". The harmonic spectrum graph will now be displayed. Use the ØA/B/C selection to move between phases.

9. Move the cursor to the "power" selection, and press "enter". The three-phase power flow values will now be displayed.

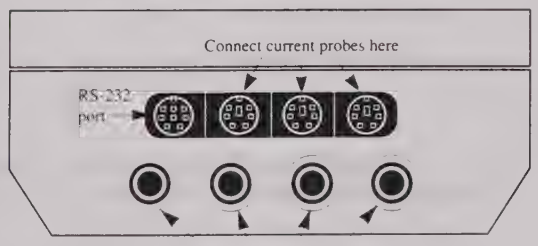
10. If you need help along the way, please consult the remainder of the User's Guide for more complete information and descriptions of the menu options. Help may also be accessed directly from the 355 Harmonics Analyzer by returning to the main menu and selecting "Definitions". Or, if you need more assistance, please call BMI Technical Support at **1-800-888-2648**, or 1-408-970-3700.

Step Two: Set up the 355 Harmonics Analyzer for Three-Phase Harmonics and Power Flow Measurements

In order to connect the 355 for three-phase measurements, you will need the instrument, four voltage probes, and three current probes.

Warning! *You are working with high voltages that cause burns and lethal shocks. Use standard safety precautions.*

1. Momentarily press the ON/OFF button on the front of the instrument. The display will show the main menu.
2. Using the cursor "arrow" keys, adjust the contrast of the display. Once a proper contrast has been reached, press the "enter" key.
3. Press "enter" again to view the set-up data. Verify that the instrument is set for the correct application (e.g. three-phase, IEEE calculations, 60 Hz, etc.)
4. Move the cursor to the "main menu" selection, and press "enter".
5. Move the cursor to the "wave" selection, and press "enter". The voltage and current waveshape screen will now be displayed.
6. Connect the current and voltage probes to the 355 Harmonics Analyzer. The figure below shows how the connectors should be arranged. Care should be taken to properly orient the three phases.



355 Harmonics Analyzer, top view—making probe connections

THREE PHASE POWER

	ØA	ØB	ØC	3Ø
RMSV	119.3	119.2	119.3	
RMSA	30.0	16.5	19.5	
KW	2.3	1.0	1.2	4.5
KVA	3.6	2.0	2.3	7.9
TKVAR	2.3	1.0	1.2	4.5
DKVAR	0.0	0.0	0.0	0.0
% TPF	+ 63.0	+ 52.4	+ 52.4	+ 55.9
% DPF	+ 99.8	+ 93.1	+ 91.4	+ 94.7

SS FR SD PR GRAPH MENU ▲

Power Menu

Setup Menu

The setup menu provides all instrument control and adjustments for the 355 Harmonics Analyzer.

CONTRAST: Adjust LCD display contrast using the cursor control keys.

BACKLIGHT: Turns backlight on and off.

Warning! *Continuous use of the backlight will shorten battery life*

SINGLE/THREE: Switches between single- and three-phase.

PHASE: Voltage and current inputs.

IEEE/IEC: Switches the harmonics calculations between IEEE format (% of fundamental value) and IEC format (% of rms value).

60 Hz/50 Hz: Adjusts input line frequency between 60 Hz and 50 Hz.

FREE RUN FAST/SLOW: Switches sampling rate for Free-Run mode. Fast sampling rate is once per second, and slow sampling rate is once every four seconds. All samples are based on four cycles of data.

NULL METER: Nulls meter to present conditions.

REMOTE COMMUNICATION: Loads the "Remote Communication" submenu. The submenu choices are:

REMOTE COMM ON/OFF: Enables remote communications.

AUTO SAMPLE ON/OFF: Enables auto sample and dumping of data to PC.

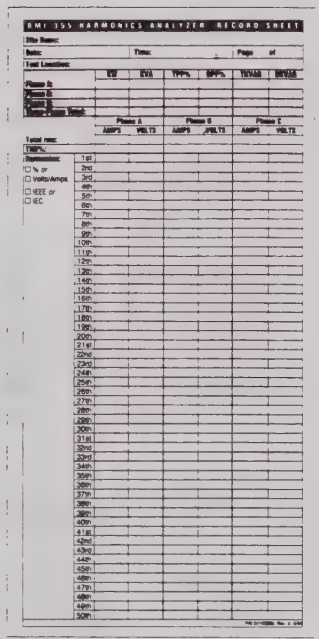
AUTO SAMPLE TIME: Time setting for delay between samples, from one to 60 minutes.

SET-UP: Return to Set-up menu.

Record Sheets

The BMI 355 Harmonics Analyzer includes fill-in-the-blank record sheets, which allow quick notes to be taken in the field without the need of the thermal printer. The record sheets are formatted so that the data can be readily recorded for later interpretation.

First, record the site name, date, time, and location. Then be sure to check off whether you are using IEEE (% fundamental) or IEC (% rms) harmonics calculations, and whether the recorded values are harmonic percentages or volts/amps. Next, write the values displayed on the 355 Harmonics Analyzer into the corresponding spaces on the record sheets.


BMI 355 HARMONICS ANALYZER RECORD SHEET

Harmonics Analyzer record sheet

How To Begin Using Your Harmonics Analyzer...

Step One: Unpack your 355 Harmonics Analyzer

Make sure the instrument and all of its accessories have been received in good order. Check for any damage which may have occurred in shipment. Be sure the following items have been included:

- 355 Harmonics Analyzer And User's Guide
- Registration And Warranty Cards
- Voltage Probes (4)
- Media Pad

The following items are optional and should have been included if ordered:

- Carrying Case With Foam Inserts
- FuseClip™ Voltage Probes (4)
- Extra Set Of Batteries
- Thermal Printer And Instructions
- Printer Data Cord
- Spare Printer Paper Roll
- Printer Battery Charger
- Current Probes - 60 Amp
- Current Probes - 600 Amp
- Current Probes - 3000 Amp
- PC Interface Cable

If you are missing any of the above items, please contact BMI Order Administration at **1-800-888-2648**, or 1-408-970-3700.

8 Glossary

Amp, ampere: The quantitative unit measurement of electrical current.

Bandwidth*: The range of frequencies within which performance, with respect to some characteristic, falls within specific limits.

Crest factor:** The ratio of the peak value to rms value of a periodic waveform.

Current: The flow of electricity in a circuit expressed in amperes. Current refers to the quantity or intensity of electrical flow.

Delta: A type of connection in a three-phase circuit, often the primary side of a transformer. A delta connection may or may not have a neutral connection.

Fundamental frequency: The primary frequency at which AC power is delivered to an end-user, usually 50 Hz or 60 Hz.

GRAPH: GRAPH is a menu choice from the 355 Harmonics Analyzer main menu, and shows the harmonic spectrum bar chart of the subject power system.

Harmonic: A frequency that is a multiple of the fundamental frequency.

Harmonic distortion: Excessive distortion in the voltage or current waveform that introduces harmonics frequencies.

Harmonic spectrum: A bar-chart showing the relative magnitudes of the harmonic distortions, usually up to the 31st or 50th harmonic.

Hz, Hertz: The frequency of alternating current. The term Hertz is synonymous with cycles per second.

K-factor: A rating system used with a certain type of transformer which has been designed to operate with non-sinusoidal currents.

KVA: Thousands of volt-amperes of apparent power.

KVAR: Thousands of volt-amperes of reactive power.

KW: Thousands of watts of actual power.

Glossary

8

Neutral conductor: One of the conductors in a three-phase wye system. Sometimes called the return conductor, it carries the entire current of a single-phase circuit and the resultant current in a three-phase system. The neutral conductor is bonded to ground on the output of a three-phase delta wye transformer.

Phase: The timing between two or more events tied to the same frequency.

POWER: A menu choice from the 355 Harmonics Analyzer main menu, and shows the three-phase power flow values of the subject power system.

Power factor: Watts divided by volt amperes, or the ratio of actual power to apparent power.

THD, Total Harmonic Distortion: A percentage describing how much a measured waveform differs from an ideal sine wave.

True rms: A term used to describe the root-mean-square value of a waveform. "True" indicates that no assumptions that the waveform is a sine wave have been made, and harmonic distortion has been taken into account.

UPS, Uninterruptible Power System: A power conditioning and supply system that provides power during outages.

Volt: The quantitative measurement of electrical force or potential also called electromotive force.

Voltage:** The force of electricity in a circuit as expressed in volts. It is the measure of work it takes to move a charge through a circuit.

WAVE: WAVE is a menu choice from the 355 Harmonics Analyzer main menu, and shows the voltage and current waveforms of the subject power system.

Waveform: The graphic form of an electrical parameter.

Wye: A three-phase connection with a single common neutral and three phase conductors.

*from IEEE Std 100-1984

**from IEEE Std 1100-1992.

Warranty

BMI warrants that the 355 Harmonics Analyzer will be free from defects in workmanship and materials for a period of one year from the date of purchase. BMI will, without charge, replace or repair, at its option, any warranted product returned to the BMI factory service department.

BMI shall not be held liable for any consequential damages, including without limitation, damages resulting from loss of use, or damages resulting from the use or misuse of this product. Some states do not allow limitations of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have rights which vary from state to state.

Exclusions: *This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized repairs or alterations.*

7 Specifications

Operation:

On-board microprocessor, 12-bit A/D conversion, crystal-controlled clock. Accuracy ensured by 64-bit math operations. Sampling Rate: 256 samples/cycle.

User Interface:

Graphic Display: LCD dot-matrix, 2 x 3 inches (5.08 cm x 7.62 cm), selectable backlighting. Adjustable contrast. Menu-driven software for setup and operation. Built-in definition text to explain instrument terminology.

Controls: Four momentary contact switches: On/Off, Cursor Left/Down, Cursor Right/Up, and Enter.

Inputs:

Voltage: Phase A, B, C, and neutral

Current: Phase A, B, and C

Communications: RS-232 for printer and PC communications

Ranges:

Voltage: 50 to 600 V_{rms} (± 1000 V_{pk}); ± 1% of reading ± 1% of full scale

Current: (For 60 A_{rms} probe): 0 to 60 A_{rms} (± 100 Apk); ± 1% of reading ± 1% of full scale

Harmonics:

Values Calculated: Distortion Factor, voltage and current for each phase, fundamental through 50th harmonic. Percent Total Harmonic Distortion. Adjustable for either IEEE (% fundamental) or IEC (% rms) harmonics calculations.

Accuracy: Voltage: 0.5%

Current: 0.5%

Harmonic specifications at 50/60 Hz, 25% to 90% full scale, subject to standard voltage and current accuracy.

Specifications 7

Power Flow:

KVA, KW, Total KVAR, Displacement KVAR, Total Power Factor, Displacement Power Factor.

Power flow values are calculated from voltage and current Inputs. Accuracy determined by V and I accuracy.

Power flow calculations are provided for phase A, B, and C and for total three- phase.

Frequency:

Line frequency tolerance: 50 Hz or 60 Hz, ± 0.1 Hz.

Printer:

High resolution graphics thermal printer, 1/2 in. per second.

Power:

Analyzer: Four (4) AA alkaline batteries. Battery-saving auto shut-off, normal 3-hour battery life. Low Battery text display.

Printer: Built-in rechargeable NiCad battery pack (charger included).

Environmental:

0° to 50° C (32° to 122° F); 0% to 95% Relative Humidity, non-condensing.

Physical:

Analyzer: 4.7 x 9.8 x 2 inches (11.94 cm x 24.89 cm x 5.08 cm); 1.7 lb (0.765 kg), batteries installed.

Printer: 8.5 x 5 x 1.8 inches (21.59 cm x 12.7 cm x 4.57 cm); 1.5 lb (0.675 kg), NiCad batteries installed.

Carrying Case:: 18 x 14 x 4.25 inches (45.72 cm x 35.56 cm x 10.79 cm); 15 lb (6.74 kg), meter, printer, and all accessories included.

Specifications subject to change without notice.

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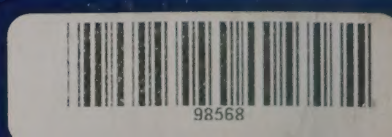
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